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SYSTEM ENGINEERING REPORT

Report No. BB-001  
Date 12/86  
Prep. by BANFIELD  
Page 1 of 10  
Alternate #

SUBJECT

TELESCOPE STRUCTURE DESIGN PROGRESS

PROJECT SOFIA

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NOTES

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Page 1 of 10

## System Engineering Report

TELESCOPE STRUCTURE DESIGN PROGRESS

SOFIA

SUBJECT

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TELESCOPE STRUCTURE DESIGN FOR SOFIA 3 METER TELESCOPE  
PROGRESS REPORT

The following is a brief report on the current design for the center-piece support structure of the telescope. The design presented on the following pages represents the current state of development for the sofia telescope structure.

## Design Parameters:

### I. Geometric Shape

In order to maximize stiffness, the center piece needs to have the largest geometric shape possible within physical constraints.

### II. Stiffness

The stiffness, as determined by the first mode natural frequency, needs be to maximized within the other parameters. The goal for the stiffness is a first mode natural frequency of 30 Hz or above.

### III. Weight

Since the telescope will be mounted in an aircraft, the weight of the structure needs to be minimized within the other parameters.

## Materials of Construction:

Two different materials for construction of the centerpiece are currently being considered: aluminum, and graphite epoxy composite. Both of these materials have high stiffness to weight ratios.

## Design:

The centerpiece structure is basically a monocoque design. As a result it was determined that the centerpiece should have the largest depth and width that is practical to fit in the telescope cavity in order to maximize stiffness. The length of the center piece was determined as a result of balancing weight and stiffness along with other physical constraints. In order to reduce weight, the plate, or skin, members making up the structure were made as thin as possible. The recommended geometric shape for the center piece design is shown on Figures 1&2.

## Optimization and Analysis:

For optimization and analysis a finite element model of the center piece was made. The plate elements were defined as small groups, and thicknesses of the groups of elements were made so they could vary independently. The model was then run through an optimization program to minimize the thicknesses of the plate elements while maximizing the natural frequency. Finally, the optimized model was analyzed using NASTRAN to determine the lowest natural frequencies. This was done for both materials using the same model.

## Results:

The results for both materials were similar with respect to weight and distribution of element thicknesses. The element thicknesses for the aluminum model are shown on Figures 3-6. The weight of the center piece structure for both materials is approximately 2,000 lbs. However, the composite model was stiffer, with a first mode frequency of 30 hz compared to 20 Hz for the aluminum model.

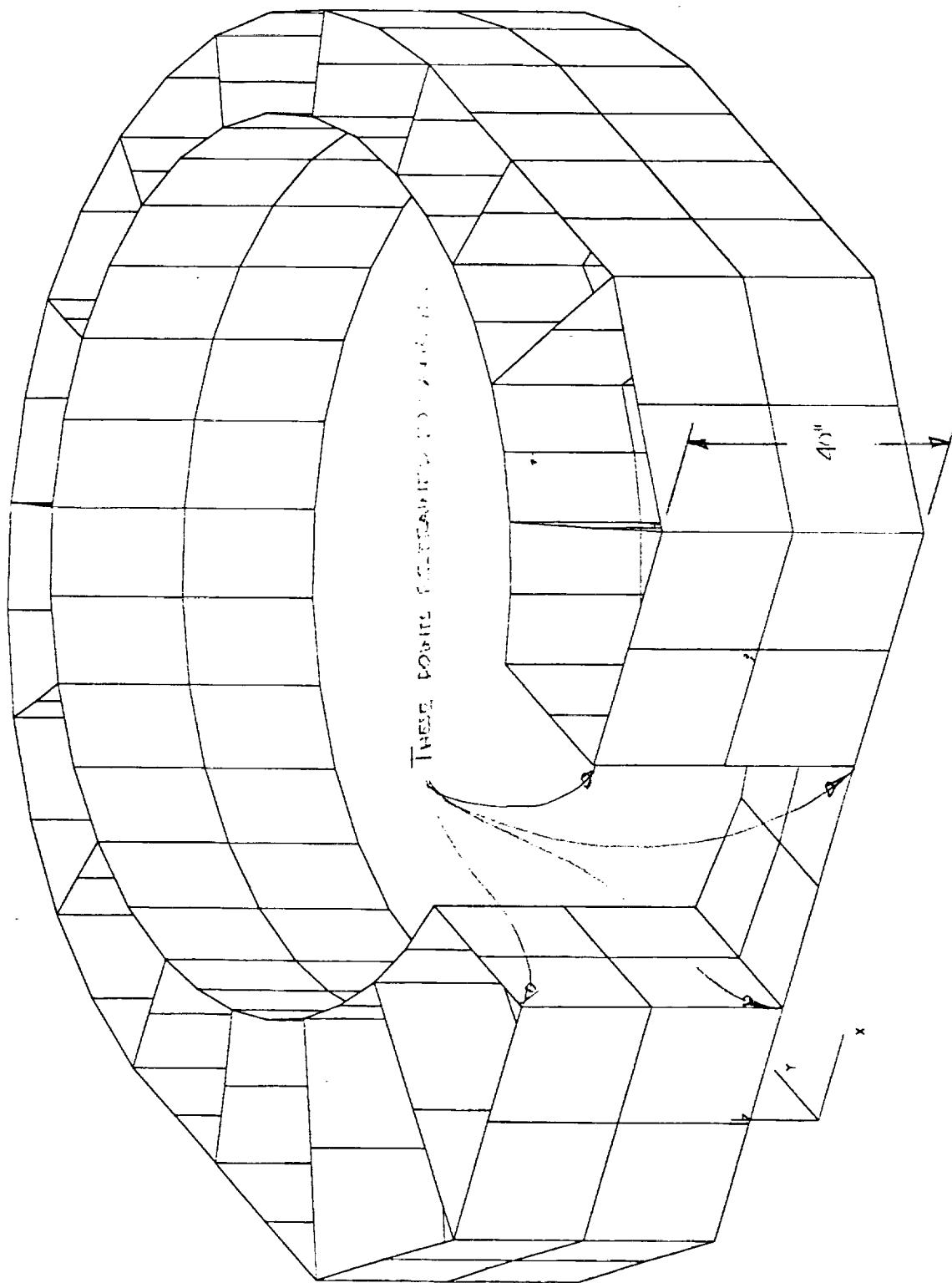
## Conclusions:

The weight for both the aluminum and composite structures was the same. The composite model does have the advantage of higher stiffness than the aluminum. However, the center piece would be easier and less costly to construct from aluminum than composite material. In addition, the actual requirement for first mode natural frequency is not yet known. Additional stiffness might be gained from adding the rest of the structure to the model as well. Therefore, both materials should still be considered for construction of the center piece.

It should be commented on here that an estimated weight for the rest of the telescope structure was included in the model as lumped masses along with respective mass moments of inertia. The estimated weight for the telescope is 8,300 lbs which indicates that a goal weight of 10,000 lbs is reasonable.

Figure 1

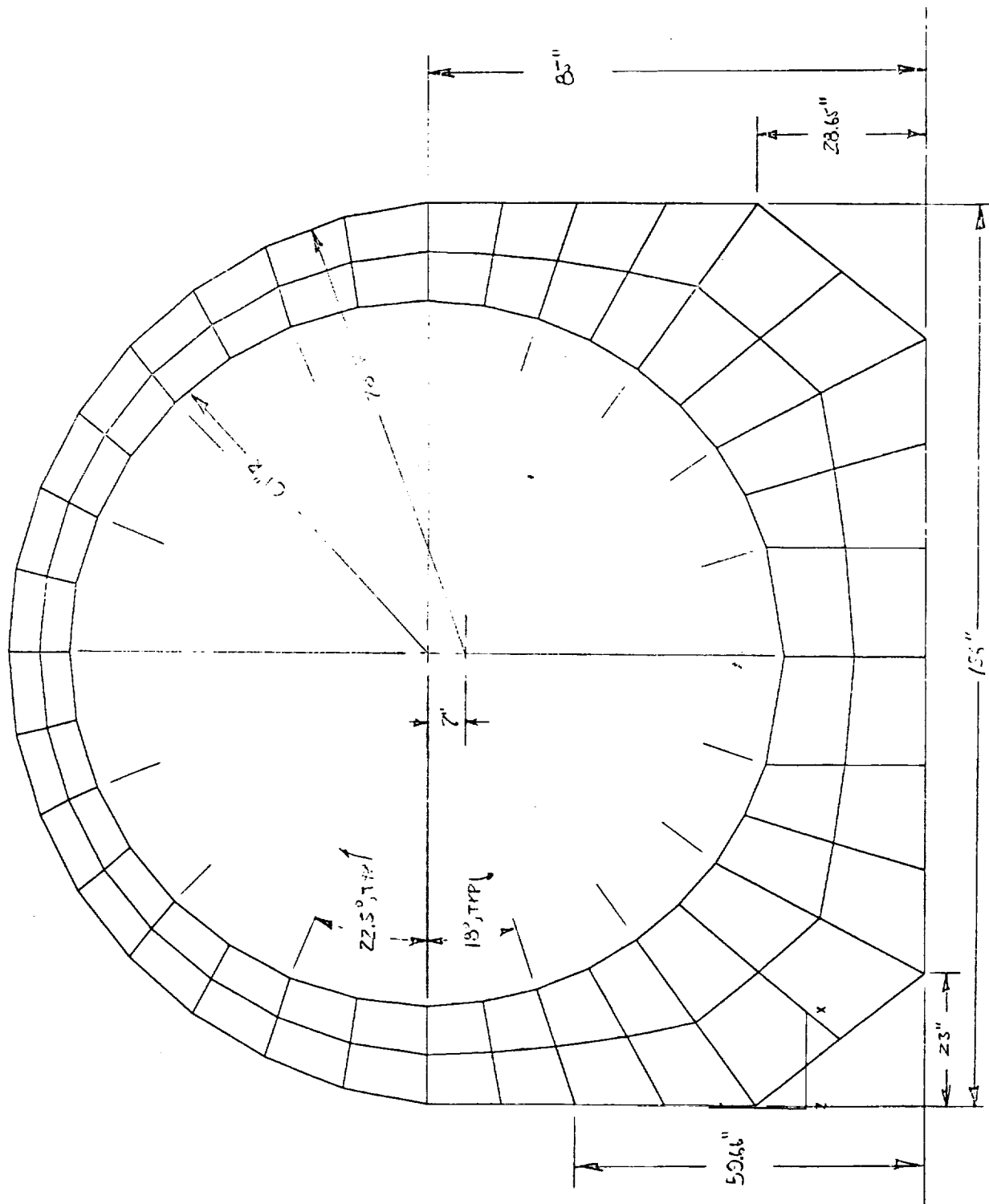
CENTER POINT DETAIL



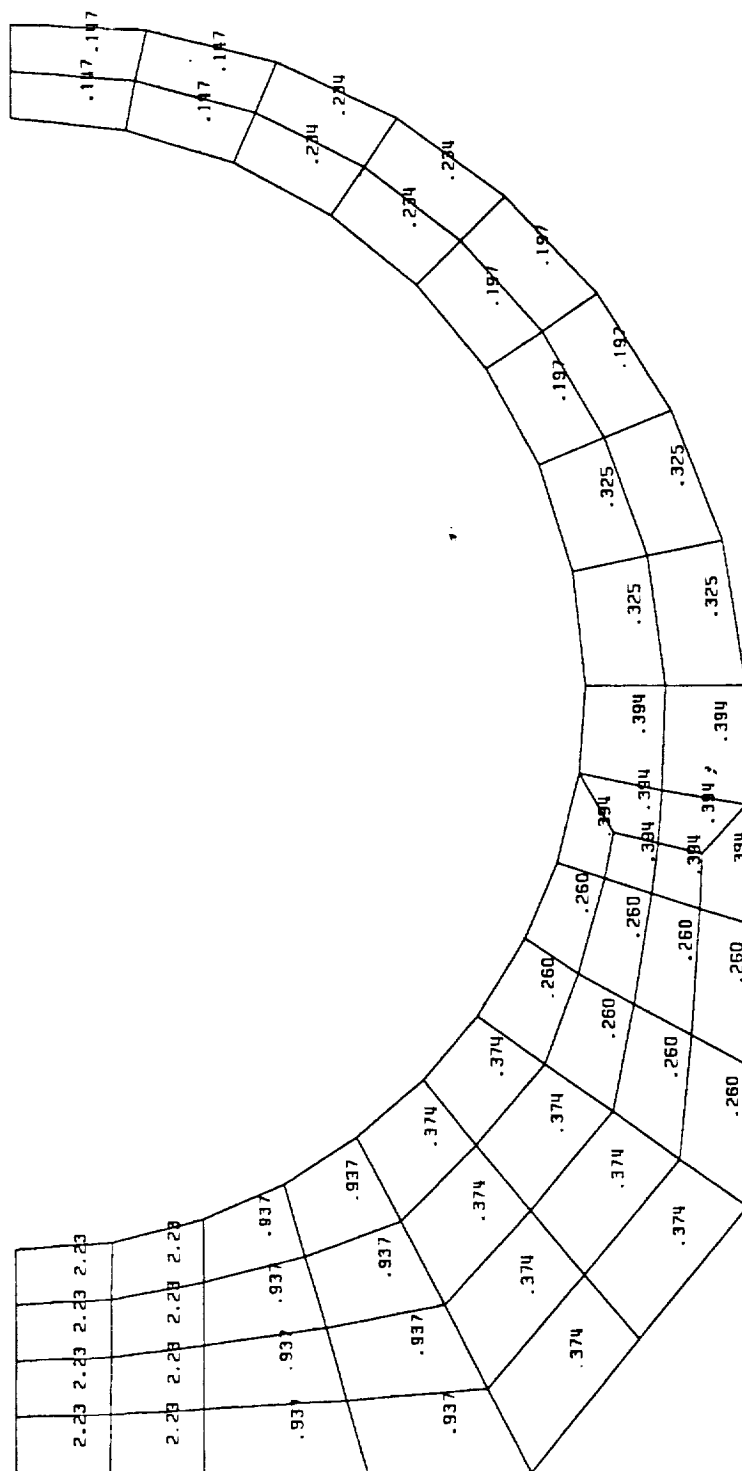
NOTE: TOP SURFACE REMOVED TO SHOW INTERIOR DETAIL

FIGURE 2

CENTER PIECE, TO 1500' LONG



Upper &amp; Lower Surveys



NOTES: SYMMETRICAL ABOUT  $C_z$   
THICKNESS IN INCHES

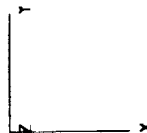
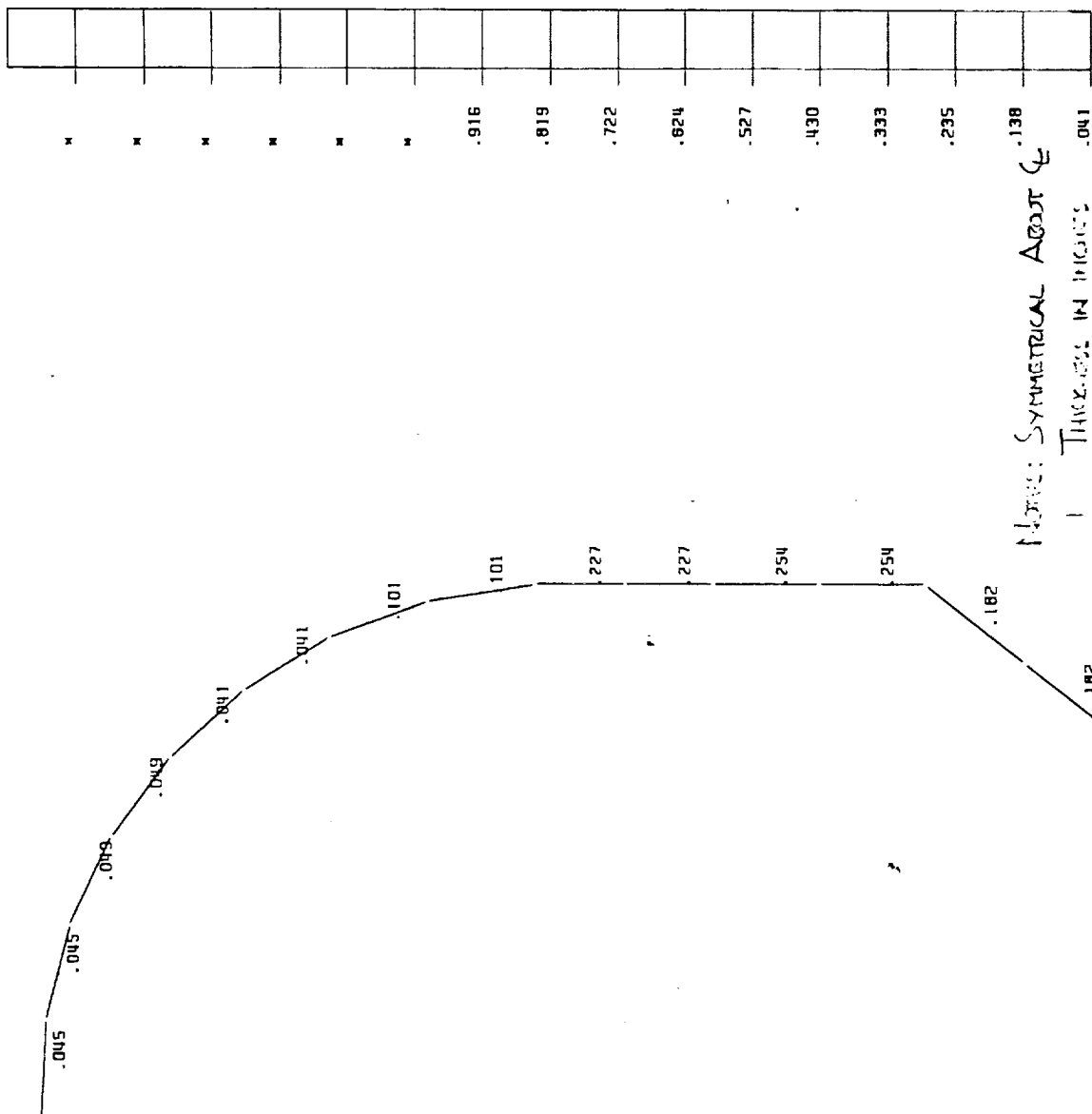






FIGURE 5

OUTER PERIPHERY RATE TOLERANCE



NOTES: SYMMETRICAL ABOUT 1.50 THICKNESS IN INCHES

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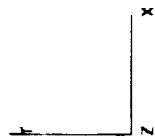


FIGURE 6

